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Save the Soil

A Study in Soil Conservation and Erosion Control

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Save the Soil

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Save the Soil

By
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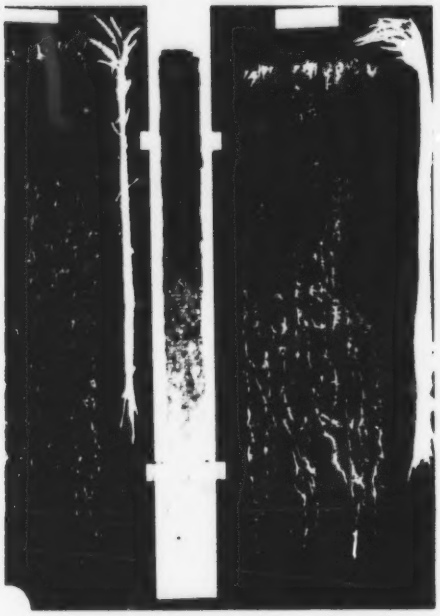
Cover Picture
Strip cropping across the slope for water erosion control near Hagen, Saskatchewan

Photo. H. M. Holm

Basic Physical, Chemical and Biological Properties of Soil and Their Influence On Soil Erosion and Erosion Control

It is necessary to know the basic physical, chemical and biological properties of a soil so that steps can be taken to apply erosion control practices to suit each individual situation. Even the most erosive soils can be protected by proper cropping and cultural practices.



Our heritage is rooted in the soil. Conserving our soils and keeping them fertile is the challenge.

On a Weyburn loam soil near Watrous, use of 11-48-0 fertilizer at 45 kg/ha (40 lbs/ac)[1] rate gave a 400 kg/ha (6 bus/ac) increased wheat yield. The increase in above ground growth can be noted by comparing the two sheaves, each harvested from two 30 cm (one ft.) rows, fertilized on the right, unfertilized on the left.

Root excavations from a 930 cm² (one sq. ft.) area of soil 1.2 m (4 ft.) deep, washed and mounted, reveal rooting depths for both fertilized and unfertilized crop. Note increased rooting, especially greater density of fine rootlets, in the fertilized root mount on the right.

Extra above ground growth and an increase in rooting density provide additional organic matter return so vital for maintenance of soil tilth, increased productivity and erosion control.

Introduction

The factors which form the nature of any soil are physical, chemical and biological. The chief physical factors are the internal arrangement of mineral and organic matter with soil water and soil air, and the external influence of topography and climate. The chief chemical factors are the mineral composition of the soil forming rock, and the type and amount of organic matter present. The biological factors are vegetation and the animals which live in and on the soil, including man.

[1]For metric conversion refer appendix B.

Soil erosion by wind or water action is mainly influenced by the soil's native physical, chemical and biological properties. Some soils erode more readily than others, particularly when brought under cultivation.

When surface soil drifts or washes away, the land remaining becomes less productive. Years of costly effort are needed to try and repair the damages caused by erosion. An eroded soil may never be completely rebuilt into its original state of fertility and tilth. The goal, therefore, must be to prevent erosion from starting.

The impact of soil erosion on soil loss and lowered productivity is not generally appreciated. Erosion of even two and one-half centimetres of topsoil per hectare is the equivalent of removing 380 tonnes of soil per hectare[1] from the land. In the Dark Brown soil zone of Saskatchewan this soil removal would represent a loss of 11 tonnes of organic matter, 940 kilograms of nitrogen, and 110 kilograms of phosphorus per hectare.

In an experiment conducted at the Agriculture Canada's Lethbridge Research Station, barley yields on undisturbed soil were compared with yields on a field from which varying amounts of soil were removed. During seven years continuous cropping to barley, the undisturbed field averaged 1755 kg/ha, with a high yield of 3260 kg/ha recorded in one year, while the field from which all the topsoil was removed averaged 625 kg/ha, the highest yield in any one year being 1000 kg/ha.

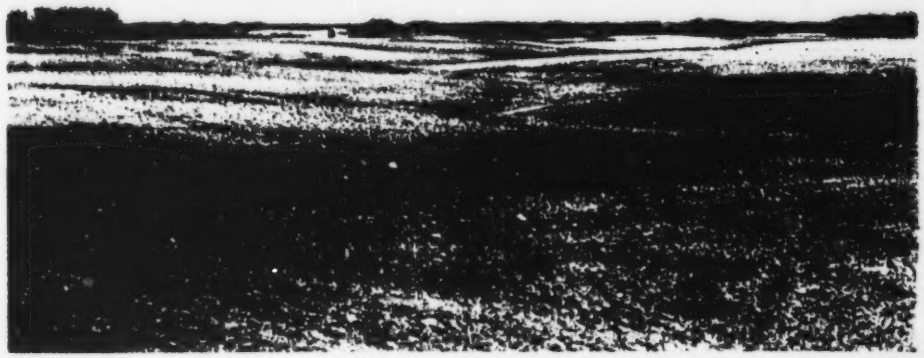
At the end of the seven year period the fields were seeded to spring wheat, fertilized with 45 kg nitrogen and 90 kg phosphate per hectare vs unfertilized, with the following yield results. In the unfertilized areas the yields were as follows: where no soil was removed, 1380 kg/ha; 8 to 10 centimetres removed, 1040 kg/ha; 18 to 20 centimetres removed, 760 kg/ha; and where 45 centimetres of soil was removed, 605 kg/ha. In the fertilized portions the yields were 1615, 1505, 950, and 970 kg/ha respectively. Loss in yield was associated with progressively greater removal of soil. While fertilizer helped recovery from topsoil loss, in no case on the "eroded" soil did the fertilizer-treated area outyield the normal soil.

Besides nutrient loss from soil erosion there is physical deterioration resulting in lower water holding and infiltration capacity and poorer surface soil structure. This subjects crops to more frequent and severe water stress, contributes to a tendancy for soils to erode more easily, results in additional energy requirements for tilling fields and filling gullies and accelerates the danger of pollution in lakes and streams.

Is topsoil worth saving? Emphatically, yes!

Farmers should know and understand the soils of their own farm and district. Soils on different farms are likely to require widely different management to control erosion. Soils on different fields, or even those within one field on the same farm, may also require different treatment.

Steps recommended to control erosion range from use of protective vegetative cover to special land use practices. To assist in erosion control and to make recommended measures more clearly understood and appreciated, the basic physical, chemical and biological characteristics of soil warrant closer study.



Summerfallow field near Kipling showing severe wind and water erosion damage.

Soil Components

Soil is made up of four main parts: — mineral matter, organic matter, water and air. There also are a host of living organisms ranging from micro-organisms to earthworms and burrowing animals. It is the degree of balance among all the parts which shapes the physical, chemical and biological make-up of any soil.

Soil Mineral Matter and Soil Erosion

Mineral matter in soil is made up of fragments of rocks in all stages of breakdown, from coarse grains of sand to microscopic particles of clay. Plant food is released from the mineral particles in the final stages of their breakdown. In most soils, mineral matter accounts for the bulk of the solid material. A black loam soil for example, contains 43 per cent mineral matter, and seven per cent organic matter on a volume basis.

The proportion of the mineral matter that is present as sand, silt or clay determines a soil's texture. Coarse textured "light" soils result when the bulk of mineral content is sand; fine textured "heavy" soils occur when the mineral content is mostly clay or silt. In between are loam textured "medium" soils, having nearly equal amounts of sand, silt and clay. (Refer Table 1).

Special steps must be taken to guard against wind erosion on sandy soils and on clay textured soils. A lumpy or cloddy structure will not form in sands. In the fine textured clays lumps and clods slake down easily. Water erosion can be the main concern on soils of silt or clay texture, especially on long moderately steep slopes. Loam textured soils can be kept in a cloddy condition more easily and are thus more resistant to erosion.

Soil Organic Matter and Soil Erosion

Soil organic matter comes from remains of animals and plants which decompose in the soil. Decomposed organic matter, called humus, gives the dark color to the surface soil. The more humus present the darker the soil color and in general, the more fertile the soil. The amount of organic matter in Saskatchewan surface soils varies from one to fifteen per cent. (Refer Table 2).

Organic matter or humus binds mineral particles together and provides a friable structure for satisfactory crop growth. It is the main source and storehouse for nitrogen and serves as food for the many living organisms in the soil.

Organic matter is important in erosion control mainly because it binds tiny soil particles into larger aggregates that are more erosion resistant than single grain particles. It also affects fertility, structure, water intake, water holding capacity and aeration. Taken together, these characteristics of soil, are commonly referred to as soil tilth. Soil tilth has a strong influence on the ability of the soil to resist erosion.

Table 1: Percentage of sand, silt and clay in four different textured Saskatchewan soil associations.

Soil Association[1]	Textural Class	% Sand	% Silt	% Clay
Shellbrook	Fine Sandy Loam	73	14	13
Oxbow	Loam	46	37	17
Melfort	Silty Clay Loam	25	47	28
Regina	Heavy Clay	12	32	56

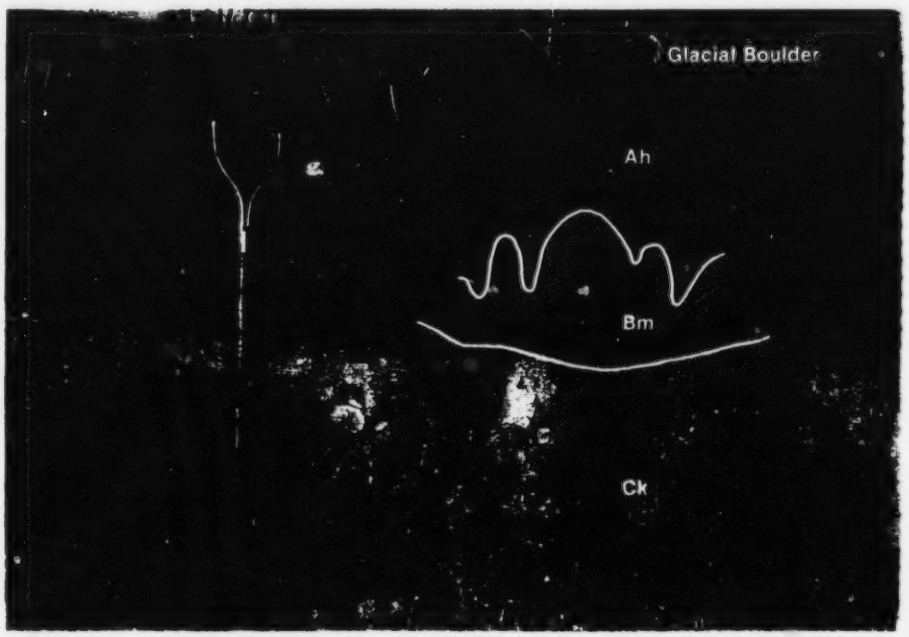
[1]For further information on the soil associations of Saskatchewan, refer to Saskatchewan Soil Survey Reports No's. 12 and 13, and Saskatchewan Institute of Pedology detailed soil survey publications available from the University of Saskatchewan.

Table 2: Percentage organic matter in representative soil associations from the different soil zones in Saskatchewan.

Soil Association	Textural Class	Soil Zone	% Organic Matter in Uncultivated Surface	Estimate of % Organic Matter after 75 years Cropping
Haverhill	Loam	Brown	3 to 4%	2%
Regina	Heavy Clay	Dark Brown	4 to 5%	3%
Oxbow	Loam	Black	7 to 8%	5%
Melfort	Silty Clay Loam	Deep Black	12 to 15%	9%
Shellbrook	Fine Sandy Loam	Grayish-Black	6 to 7%	5%
Waitville	Loam	Gray-Wooded	3 to 4%	3%
Pine Sands			1%	

Soil Water and Soil Air and Soil Erosion

Water and air exist in soil in the spaces between the soil particles. Soil water may occur as a film covering the soil particles, or



A glacial till soil profile. The dark surface layer (Ah horizon) is the end result of centuries of weatherir addition of plant and animal remains, and the work of many living organisms. The less fertile, lighter colored subsoil (Ck) has little organic matter. Note the tonguing of the Ah horizon into the Bm. The Ah horizon is the zone of eluviation (loss), the Bm is the zone of illuviation (gain), the Ck is the unaltered calcareous parent material.

it may be present throughout the gel-like clay and humus. Soil air fills pore spaces not occupied by water. Consequently, the more saturated a soil becomes, the poorer will be the aeration and oxygen supply.

Clay soils may become so saturated with water that aeration is restricted and plant growth is reduced. Sandy textured soils and loam soils on rolling topography having low moisture holding capacity, frequently show drought symptoms and are thus less productive.

Soil water and air affect soil erosion indirectly through their influence on crop growth. When the crop growth is restricted by an imbalance between soil water and soil air there is less growth and less stubble and residue. Reduced soil cover increases the chances of damage by erosion. Soil water is also of direct importance on most soils in developing a cloddy structure necessary for erosion control.

Soil Chemical Properties and Soil Erosion

The soil's chemical make-up works indirectly through crop growth to affect erosion. Soil fertility, soil salinity, soil pH (acidity or alkalinity) for example, strongly influence production and the quantity and quality of residues available to protect soil against erosion.

For more information on these soil chemical properties refer to the following Saskatchewan Agriculture publications: Saskatchewan Fertilizer Practices; Understanding Salt Affected Soils; and to Agriculture Canada's publication 1521 — Farming Acid Soils in Alberta and North Eastern British Columbia, available from Federal and Provincial Agriculture offices and from the Universities.

Soil Biological Properties and Soil Erosion

The biological agencies within the soil, from micro-organisms to larger animals are important agencies in the breakdown of mineral matter and organic matter into essential foods for growing crops.

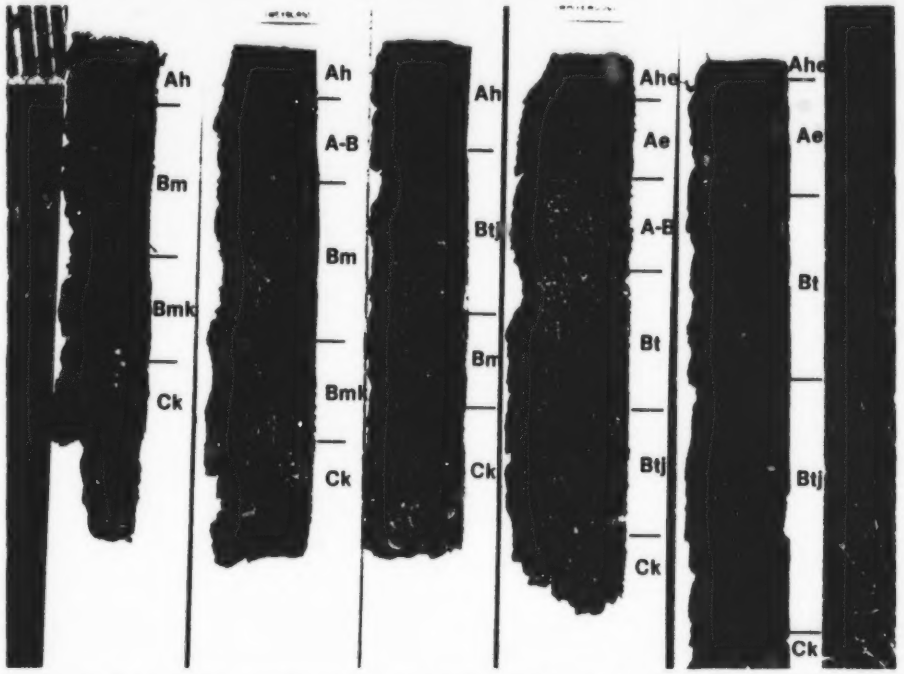
A soil with an active biological population is a living thing and promotes the healthy crop growth needed to protect it from erosion.

Summary

It is necessary to know the basic physical, chemical and biological properties of a soil so that steps can be taken to apply erosion control practices to suit each individual situation. Even the most erosive soils can be protected by proper cropping and cultural practices.

Recommended erosion control practices include use of trash cover farming, commercial fertilizers and farm manures, strip cropping, field shelterbelts, contour strip cropping, grassed waterways and mechanical aids, cover cropping, grasses and legumes in rotation. These practices, properly applied, can reduce the erosion hazard of any soil.

Each of these erosion control practices will be discussed in detail in the following pages. At the outset it should be noted that, although discussed separately, usually not one, but several of these measures must be used together if erosion control is to be fully effective.



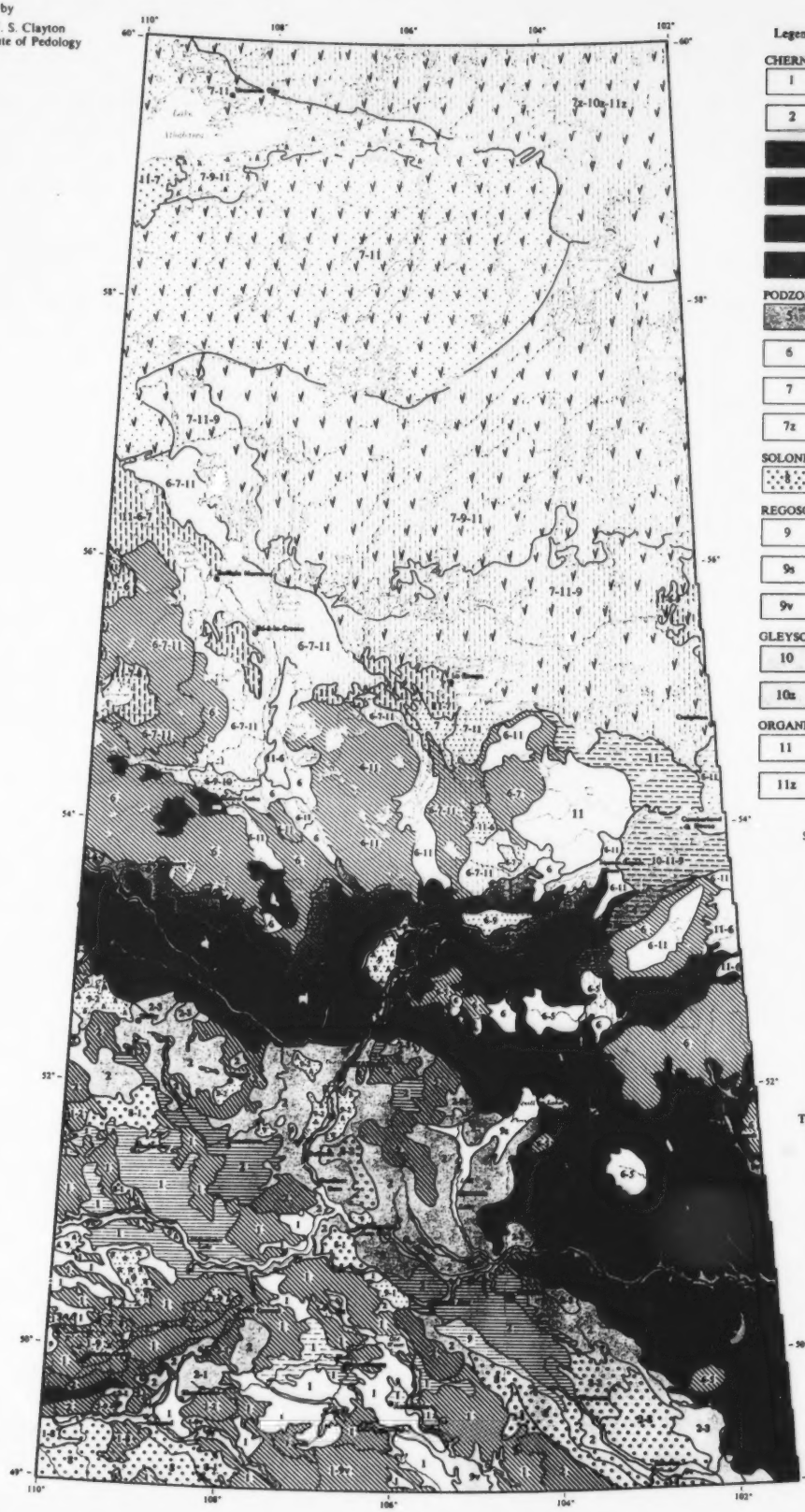
Five glacial till soil profiles, one from each of the five major soil zones of Saskatchewan. From left to right are: Brown Haverhill profile, Dark Brown Weyburn, Black Oxbow, Grayish-Black Whitewood and Gray-Wooded Waitville. Note the darkening of surface color and thus increasing organic matter content of the Ah horizon from Haverhill to Oxbow soil and the shallow Ahe and grayish Ae horizons and thus lower organic matter content of the Waitville profile. These profiles are about one and a quarter meters deep.

Photo A P Edwards

Soil tilth reflects a conditioning of the soil which can be seen and felt. Here, on the left, is a massive soil in poor tilth; on the right, a granular soil in good tilth.

Soil Map of Saskatchewan

Compiled by
H. C. Moss and J. S. Clayton
Saskatchewan Institute of Pedology
1967



Legend

CHERNOZEMIC (Dark coloured grassland soils)

- 1 Brown
- 2 Dark Brown
- Black
- Black Calcareous
- Dark Gray
- Dark Gray Calcareous

PODZOLIC (Light coloured forest soils)

- 5 Dark Gray Wooded
- 6 Gray Wooded
- 7 Podzol
- 7z Cryic Podzol (Podzol with frozen subsoil)

SOLONETZIC (Hard, poorly structured soils)

- s Solonetz and Solod (Occurring in various zones)

REGOSOLIC (Weakly developed soils)

- 9 Undifferentiated Regosols
- 9s Saline Regosol
- 9v Valley Complex (Chiefly Regosolic soils of valley slopes and bottoms)

GLEYSOLIC (Wet, poorly drained mineral soils)

- 10 Peaty Gleysol
- 10z Cryic Peaty Gleysol (Peaty Gleysol with frozen subsoil)

ORGANIC (Wet, poorly drained peat soils)

- 11 Fibrisol (Deep moss peat)
- 11z Cryic Fibrisol (Deep moss peat with frozen subsoil)

Soil Texture

- Sandy (loamy sands, sands, gravel)
- Loamy (Sandy loams to silty clay loam)
- Clayey (Silty clay to heavy clay)
- Mixed sandy and loamy
- Mixed clayey and loamy

Topography

- Level to gentle rolling (0%-10% slopes)
- Moderately rolling to hilly (10%-30% slopes on 40% or more of area)
- Dunes
- Rough rock land (bedrock exposures)

Example of Soil Complex (mixed soil area)

- 6-5-11 Dominantly Gray Wooded with significant occurrence of Podzol and Organic soils

- Zonal Soil Boundary
- Soil Boundary

Atlas of Saskatchewan
Editor: J. H. Richards Cartographer: K. I. Fung
Department of Geography
University of Saskatchewan

Latitudes north of Equator
Longitudes west of Greenwich

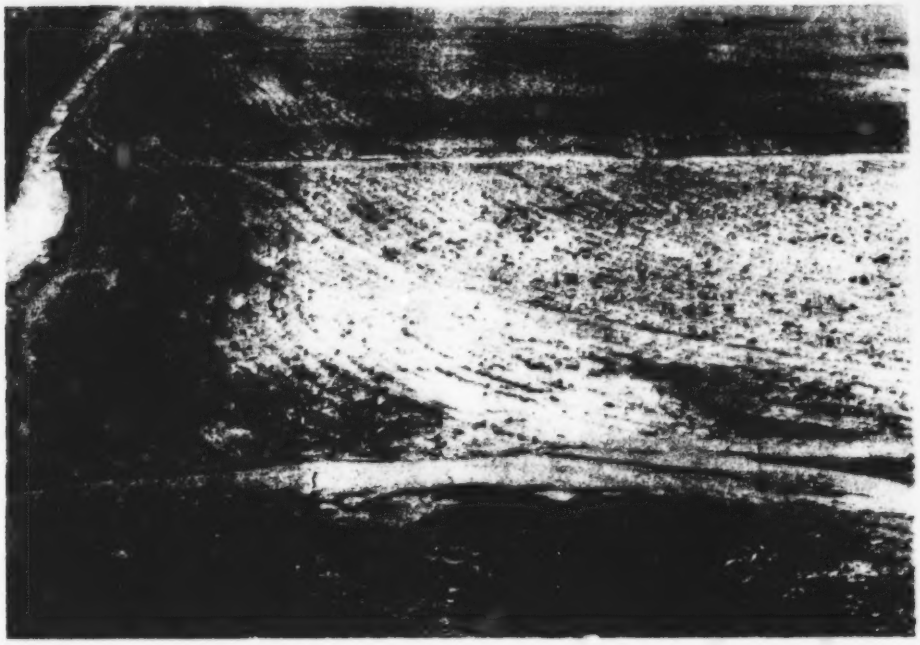
20 0 20 40 60 80 100 Miles

Trash Cover Farming For Soil Erosion Control

Use of trash cover to protect soil against wind and water erosion should be the main feature in any program of erosion control. The practice of trash cover or stubble mulch farming means the maintaining of straw and stubble residues at the soil's surface during an entire summerfallow period. Lack of trash cover is perhaps the greatest single factor contributing to erosion damage on many farms.

When a drift ridge like this forms considerable soil damage has been done, and changes in farm practices are long overdue. Large fields worked excessively with disc implements have little to protect them from wind damage.

Photo: D. J. Blackburn



A powdered surface without trash cover on sloping land is vulnerable to the severe sheet and rill erosion shown here. This is typical of water erosion damage on fields where summerfallow tillage is done with discer and harrow.

How Trash Cover Helps

Trash cover lessens soil drifting by reducing wind velocity near the soil surface. This serves in effect, to upgrade a soil texture otherwise considered vulnerable to wind erosion damage.

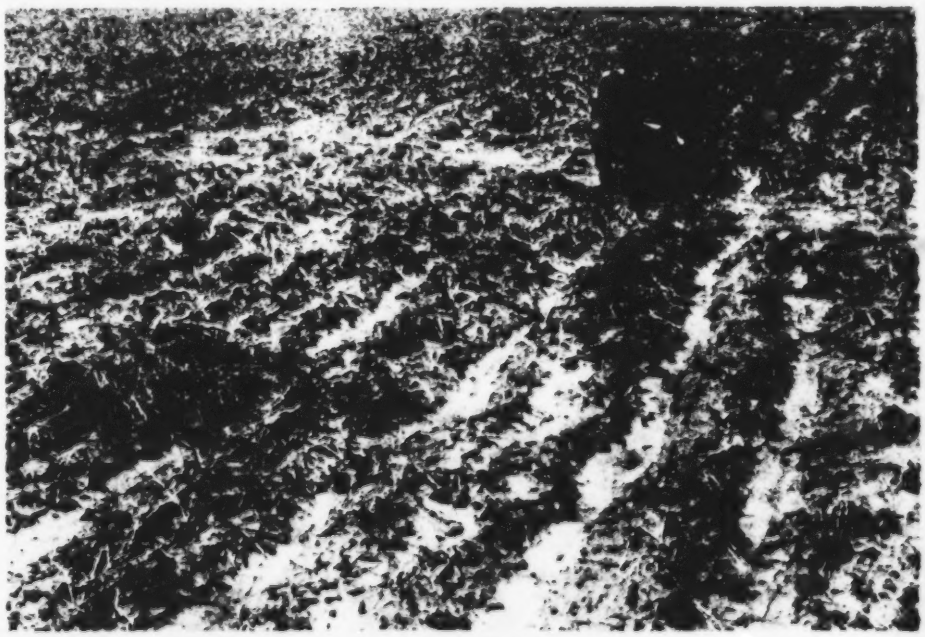
A trashy covered surface assists in water erosion control by bearing the brunt of rainfall impact. Anchored trash helps prevent soil clods from being broken down to clog soil pores. With soil pores kept open, more rainfall is absorbed by the soil and less water runs off. Less run-off means less erosion.

Anchored trash may act as small check dams against water moving down a slope. The result is less soil lost and more water stored in the soil.

Experimental Evidence

Results of experimental work in Canada and the United States show that trash cover summerfallow may take in water up to twice as fast as bare summerfallow under heavy rainfall.

Water intake rates were studied in Wyoming on a silty clay loam soil with a 2 to 3 per



This fallow field in northeastern Saskatchewan had just borne the brunt of a flash 15 cm midsummer rain. Yet because trash was anchored by a heavy duty cultivator worked across the slope, very little run-off and erosion occurred.

cent slope. Artificial rain was applied at a rate of seven and one-half centimetres per hour for a one hour period. It was found that the trash cover fallow absorbed seven centimetres of water in one hour compared to four centimetres on the bare fallow.

In an Indiana study, artificial rainfall was applied at six and one-third centimetres per hour to a silt loam soil with a five per cent slope. It was found that a trashy fallow not only improved water intake but reduced soil losses considerably. Two and one-quarter tonnes of straw mulch per hectare held soil losses to one-half of a tonne per hectare, while four and one-half tonnes of mulch practically eliminated all run-off and erosion. Fallow plots without trash cover protection lost twenty-seven tonnes of top soil per hectare. These results can be considered as similar to what happens under Saskatchewan conditions.

Amount of Residue or Trash Required for Protection

For protection during the twenty-one month fallow period, research findings suggest soils require the following amounts of residue per hectare; sandy to sandy loams — 1925 to 3300 kilograms; very fine sandy loams to silt loams — 1320 to 2750 kilograms; silty clay loams to clay soils — 1100 to 2200 kilograms; and clay loams to silty clay loams — 825 to 2200 kilograms.

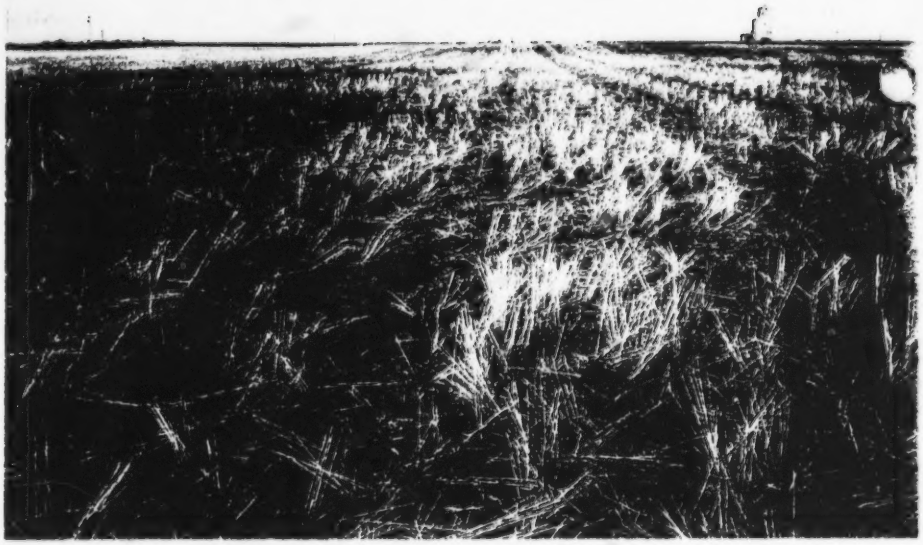
As a general rule, sandy textured soils require greatest amounts of trash cover where wind erosion is the main problem. Clay soils which slake down readily are an exception and should be classed in the range for sandy loam soils. Silt and clay soils occurring where water erosion is the main problem should also be classed in the sandy loam soil range.

Determine Amount of Residue Present

How much trash is available at the start of the summerfallow program? A general "rule of thumb" is that for each bushel of wheat or cereal grain harvested about 80 to 110 kilograms of trash or residue per hectare is left on the soil. If the ground is covered completely, there will be close to 3300 kilograms of residue per hectare.

Choose Tillage Implements Which Maintain Trash[1]

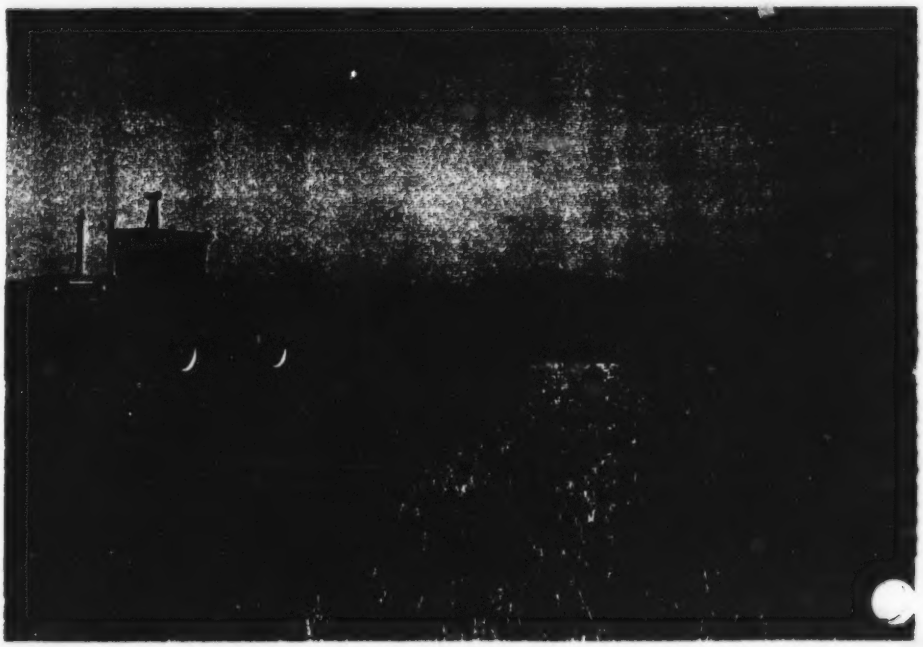
The most important single measure for any farmer to use to ensure a degree of safety from potential soil loss is to maintain a trashy surface on fallow. This can best be done by using a medium or heavy duty cultivator and blade or rodweeder, and operating at slow speeds. High speeds, especially in combination with high lift shovels, tend to pulverize the soil and throw trash loose on the soil surface where it is easily blown away. High lift shovels have gained acceptance for herbicide incorporation but are dangerous in erosion prone situations. The ideal trash cover has straw and stubble firmly anchored in the surface soil and this can best be accomplished at slow speeds using low lift shovels.



A Moose Jaw district summerfallow field in September after a complete season of tillage using a cultivator with low-lift shovels at slow speed. Note abundance of anchored trash to go into winter.

Blade cultivators, designed to operate through heavy trash, reduce surface residues about ten per cent on each operation. The Lethbridge Agriculture Canada Research Station reports 73 per cent of original surface material conserved after three operations with the blade cultivator. One problem is to get a weed kill when the soil stays moist. Blade machines operate best in light to medium soils and do not perform as well in clay soils unless dry or firm.

The rod weeder reduces trash about five to ten per cent by each operation. It is an



Seeding at Matador Co-op Farm with discers directly into standing stubble. One-way discers have historically served quite satisfactorily as "once-over" seeding machines in extended cropping rotations.

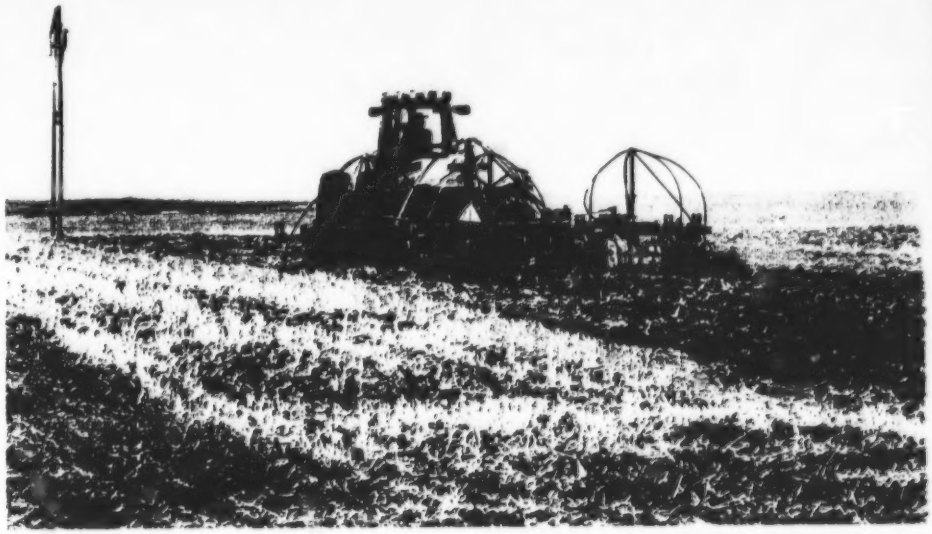
[1]Reference: — Tillage: When, Why, How. Manitoba Agriculture — Agdex 21/741. 1981.

excellent tool for secondary tillage to firm the soil and control weeds. It fits in very well for pre-seeding or after seeding use. Often the rod weeder will bring more trash to the surface if it follows a cultivator or one-way disc. In one trial at Lethbridge the one-way disc buried 575 kilograms of straw during the first tillage. Two secondary operations with the rod weeder lifted 90 kilograms or 16 per cent of this buried material back to the surface.

Medium or heavy duty cultivators will reduce residues about 15 to 20 per cent for each trip. Experimental data from Lethbridge show 65 per cent of the original cover conserved after three operations with the heavy duty cultivator. This machine disturbs the soil more and gives better weed kill than the blade or rod weeder. The cultivator and rod weeder work well in a combined operation.

Even with cultivators, however, the types of shovels used, and the speed and depth of operation strongly influence the amount of trash conserved during summerfallow. Research work at Lethbridge, using a heavy duty cultivator with 40 or 45 centimetre sweeps, showed that a slow speed (5 kilometres per hour), shallow depth (5 centimetres) tillage left 55 per cent of 910 kilograms of an original 1650 kg per hectare cover after three operations while the high speed (8 km/h), deeper (10 cm) tillage operation left only 25 per cent or 410 kg of protective trash. In the first case the soil had some wind protection but in the second case it was practically unprotected.

One-way discs and discers will bury from 30 to 70 per cent of the residues each trip depending on the type of disc and how it is operated. Generally, the greater the speed and the deeper the operation, the less trash remains. Large discs with extreme concavity and wide spacing bury more trash. One-way discs or discers should not be used unless residues are exceptionally heavy and then not more than once. While the one-way discer may be a poor implement for maintaining trash on summerfallow, it is a proven performer as a "once-over" seeding machine in stubble cropping. Another "once-over" seeding machine gaining prominence is the air seeder.



Air seeders are versatile units suited for mounting on regular cultivators for once-over stubble seeding or for deep banding fertilizers. Some types require special cultivators.

Photo: L. A. McLean

Chemical Fallow as a Means of Keeping Trash

In the attempt to maintain adequate trash on summerfallow, substitution of herbicides for tillage seems warranted. Research studies conducted over many years at Agriculture Canada's Melfort Research Station indicate that a combined tillage-chemical method can replace three to five tillage operations in the parkland region. Results show that two herbicide applications, one for annual grasses and broadleaved weeds in the spring, and one for perennial broadleaved and winter annuals in the fall, plus one or two summer tillage operations, give the best erosion control combination without reducing the moisture or nutrient level of the soil or lowering subsequent crop yields.

Melfort results reveal that the exclusive use of herbicides in summerfallowing (no tillage) still maintained adequate moisture and nutrient levels, but there was a tendency for grassy weeds to become a problem. New herbicides on the market, although costly, are showing promising results in the control of grassy weeds and volunteer grain.

Summary

Success in trash cover farming depends on choosing tillage machines and herbicides which keep maximum trash and maintain a good seed bed. This can be achieved best by following three basic steps. First, determine the amount of residues needed to protect the particular soil during the entire summerfallow period. Secondly, estimate the amount and condition of residues on fields at the beginning of the season. Finally, select the proper tillage machines and herbicides for each set of conditions and use them wisely.

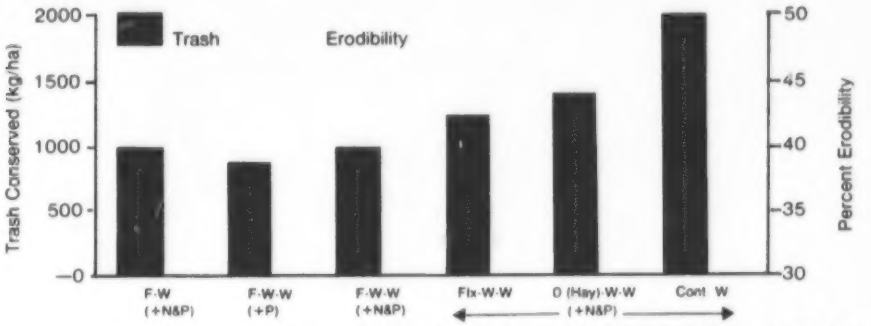
A Moose Jaw district summerfallow field in September after a complete season of chemical fallow treatment. Winter wheat was seeded in August with a no-till drill directly into standing stubble.

Commercial Fertilizers, Farm Manures and Legume Incorporation For Soil and Crop Improvement and Erosion Control

Fertilizers and manures can be of vital importance in soil erosion control programs. Their use results in increased plant growth and production. More than 40 years of fertilizer testing in Saskatchewan has shown very favorable crop response on many soils.

Unthrifty non-fertilized strip of fallow wheat in a field fertilized with 11-48-0 at 45 kilograms per hectare. The tremendous amount of extra growth produced with fertilizer will help protect the soil from erosion. Note wise use of other erosion control practices on this farm near Elrose — strip cropping, trash cover on fallow and grassed waterway.

Comparison of Trash Conserved (kg/ha) and Soil Erodibility (%) For Various Crop Rotations and Fertilizer Applications. (Swift Current Agriculture Canada Research Station).



A summary of the first 12 years data from the Swift Current Research Station's long term rotation study shows the relationship between trash conservation and erodible soil (% of soil particles less than 0.42 mm) as affected by crop rotation and fertilizer application. Note that conserved trash increases and erodibility decreases when going from use of frequent summerfallow to continuous cropping. The importance of balanced fertilizer use shows when comparing F-W-W (+P) to F-W-W (+N&P).

Key: F = fallow, W = wheat, Flx = flax, O = oats, Cont. W = continuous wheat, N = nitrogen and P = phosphorus

Fertilizer Response of Summerfallow Crops

The long time average yield increase from the use of 45 kilograms per hectare of 11-48-0 on summerfallow wheat, is about 350 kilograms per hectare for Saskatchewan. Recent experimental data indicate an increased straw yield of one-half to three-quarter tonne per hectare as well. Other benefits of phosphate fertilizer use include: better stooling, more vigorous early growth, less browning root rot, better competition with weeds, earlier maturity, more uniform ripening and generally better grades of grain.

Soil tests indicate that, following years of cropping, accentuated by erosion, more and more summerfallow fields are in need of nitrogen as well as phosphorus. (Refer

Fertilizer Benefits for Erosion Control

A major benefit of fertilizer use for erosion control is the added soil protection from extra total growth produced. The extra straw and stubble guarantees better trash cover for the summerfallow period. The prospect of being able to keep a better trash surface on fallow may be reason enough in itself to use fertilizer.

In addition, the extra straw and root materials, upon decomposition, return more humus to the soil. This promotes better soil aggregation. Improved soil aggregation means better soil permeability and less erosion. This becomes even more apparent in extended cropping rotations where summerfallow is less frequently used.

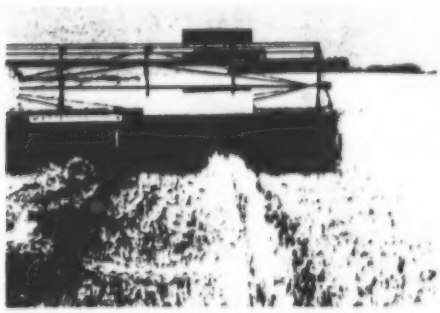
Fertilizer use promotes faster, more uniform germination and gives crops an early advantage over weeds. In this experimental field near Birch Hills, the early growth advantage provided by 11-48-0 at 45 kilograms per hectare to strips of wheat on fallow has helped to develop a healthy, vigorous crop. In the unfertilized strips the wheat has been almost entirely crowded out by the weed Persicaria (lady's thumb).

Appendix A). Many summerfallow fields may require the nitrogen-phosphorus fertilizers listed for stubble crops.

Fertility Needs of Stubble Crops

For maximum production on stubble extra nitrogen may be needed in addition to regular phosophorus requirements. Additional nitrogen can be supplied by seed placing nitrogen-phosphate fertilizers such as 23-23-0, 28-28-0, 34-17-0 or 16-20-0 or other blends. The straight nitrogen fertilizers ammonium nitrate, ammonium sulphate, urea, anhydrous ammonia or nitrogen solutions may be required where nitrogen needs are particularly great. These are traditionally broadcast or sprayed on the soil surface and worked in, except anhydrous ammonia which is shanked in. Deep banding of dry or solution nitrogen fertilizers using implements like air seeders is possible. In most cases where straight nitrogen fertilizers are used phosphorus should be seed applied.

The introduction of new fertilizers, herbicides, air seeders, no-till drills, and improved methods of moisture conservation through snow management is making it possible to more readily crop stubble land thus reducing dependence on summerfallow as a farm practice.



Snow trap stubble strip produced by deflector attachment on swather. Research indicates that each additional 10 to 15 cm of snow trapped can mean an extra 2 to 3 cm of water for crops.

Photo G. C. Zoerb

The inclusion of legume crops in the farm rotation is a good way of fertilizing when nitrogen is the main requirement. Sweet clover and alfalfa worked into the soil as green manure, return as much as 80 to 100 kilograms of nitrogen per hectare to the soil. (Refer Table 3 — See reference, page 22). Apart from nitrogen return, legumes also are most useful to improve soil condition and tilth.

Value of Farm Manures

The most important benefit of farmyard manure for erosion control is the great quantity of straw residue supplied to the soil. Manure also contains on the average, e kilograms of nitrogen, two and one-half kilograms of phosphate and five kilograms of potash per tonne. Humus formed from manure is more quickly obtained, is longer lasting and is of better quality than humus resulting from cereal crop residues. Applied at 25 to 30 tonnes per hectare, manure adds considerably to the soil's nutrient supply and contributes to increased cereal crop production.

Experimental Evidence

Results for a 26-year experiment carried out by the Melfort Research Station on a black soil at Parkside show a 500 kilogram per hectare increased wheat yield on summerfallow where 27 tonnes per hectare of barnyard manure was applied every four years. Following eight years at Star City on a Gray-Wooded soil, manure applied at 27 tonnes per hectare once every three years increased the yield of wheat on fallow by 430 kilograms per hectare. At the Regina Research Station a 15-year experiment on a Dark Brown soil shows a 325 kilogram per hectare increased wheat yield where 20 tonnes per hectare of barnyard manure was applied every summerfallow year in a two-year rotation.

Fertilizer Recommendations

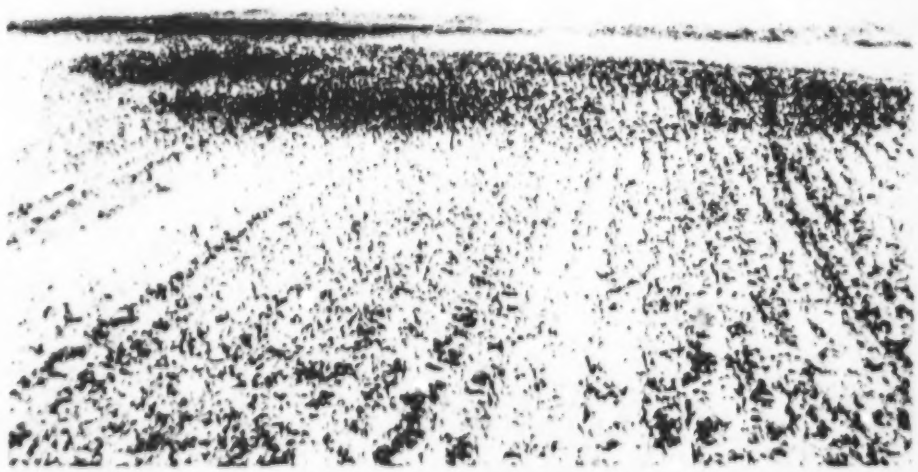
For more detailed information on fertilizer and manure use, see "Saskatchewan Fertilizer Practices Bulletin" and "Manures and Compost Bulletin", available from Federal and Provincial Agriculture offices, from Universities or from fertilizer or grain dealers.

Experimental Evidence

Table 3: Yield of nitrogen from tops and roots of sweetclover, alfalfa, and red clover at five growth stages[1]

Growth Stage and date of sampling	Legume	Kg N/ha					
		Melfort			White Fox		
		Av. 2 tests 1956 & 1960			Av. 5 tests 1956-1960		
		Tops	Roots	Total	Tops	Roots	Total
Seedling year (September 15)	Sweetclover	22.8 *a*	9.4 *a*	32.2 *a*	40.4 *a*	16.6 *a*	57.0 *a*
	Alfalfa	15.7 *a*	7.2 *a*	22.9 *a*	37.3 *a*	15.2 *a*	52.5 *a*
	Red clover	20.8 *a*	4.6 *a*	25.4 *a*	29.1 *a*	8.4 *b*	37.5 *b*
Spring second year (April 15)	Sweetclover	—	29.2 *a*	29.2 *a*	—	35.8 *a*	35.8 *a*
	Alfalfa	—	8.2 *b*	8.2 *b*	—	24.5 *b*	24.5 *b*
	Red clover	—	9.8 *b*	9.8 *a*	—	19.8 *b*	19.8 *b*
Early bud (June 15)	Sweetclover	54.8 *a*	12.8 *a*	67.6 *a*	65.5 *a*	10.3 *b*	75.8 *a*
	Alfalfa	30.9 *b*	10.1 *a*	41.0 *b*	65.8 *a*	16.3 *a*	82.1 *a*
	Red clover	24.8 *b*	10.3 *a*	35.1 *b*	48.9 *b*	12.6 *a*	61.5 *b*
Full bloom (July 13)	Sweetclover	73.1 *a*	9.7 *a*	82.8 *a*	83.1 *a*	10.8 *a*	93.9 *a*
	Alfalfa	60.2 *a*	28.2 *a*	88.4 *a*	70.9 *a*	29.8 *a*	100.7 *a*
	Red clover	49.8 *a*	19.7 *b*	69.5 *a*	62.1 *a*	19.0 *b*	81.1 *a*
Mature seed (September 15)	Sweetclover	53.6 *a*	10.7 *b*	64.3 *b*	53.8 *a*	9.4 *a*	63.2 *b*
	Alfalfa	49.4 *a*	54.8 *a*	104.2 *a*	53.8 *a*	38.5 *a*	92.3 *a*
	Red clover	68.5 *a*	24.8 *b*	93.3 *a*	66.9 *a*	24.8 *b*	91.7 *a*

*Means followed by the same letter are not significantly different ($P = 0.05$).
[1]Melfort Research Station data published in Can J. Plant Sci. Vol. 49, 61-68 (1969)



The crop on this eroded sandy field near Arelee is, for the most part, pale and unthrifty. On the knoll in the background where barnyard manure had been applied during the previous fallow season, a greener, healthier crop is apparent.

Strip Cropping For Wind Erosion Control

Where soil drifting is a problem, benefits obtained from strip cropping seem to outweigh its disadvantages. Even with the best possible summerfallow practices, there is danger of erosion damage if fields are farmed in large blocks. Strip cropping offers an effective way of reducing field size to combat wind erosion, without changing basic farm practices.

Roadside ditch filled with topsoil during severe blow across a large unprotected fallow field in central Saskatchewan.

Mechanics of Wind Erosion

Wind action works in a cumulative way to cause soil drifting. Initially, a bare, powdered soil sets the stage for soil movement when high winds strike. Once soil drifting starts, small sand grains and soil granules are bounced along to strike and loosen and powder other particles, which in turn are carried by the wind. Since this cumulative erosion becomes most apparent when large fields are exposed, it suggests the importance of strip cropping as a means of erosion control.

Strip Cropping Designs

There are various ways of re-arranging block fields into strips. The usual method is to start with fields to be summerfallowed. In a two year fallow-grain rotation the field is first divided into strips of the desired width. Every other strip is then seeded to spring grain and the remaining strips are summerfallowed. In a three year fallow-grain-grain rotation two strips are seeded to spring grain and the third is summerfallowed.

Another method is to seed fall rye into stubble land in the fall. The following year fall rye strips may be left for grain or feed while in-between strips are summerfallowed. This is a very useful method in sandy areas where fall rye seems best adapted.

In years of adequate moisture, it may be desirable to seed every strip. This is fine provided recommended fertilizer and weed control measures are used. It is most important, that when summerfallow becomes necessary again, former stripping plans are followed.

In emergency situations temporary strip cropping designs may be arranged. Three to five row flax barriers seeded north and south or preferably in a north-east, south-west direction at 15 to 20 metre intervals on summerfallow fields in mid July will help protect the fields from wind erosion and trap extra snow over winter.

If by September summerfallow fields have volunteer grain and broadleaved weeds, the protective grain cover can be left for frost kill and the broadleaves sprayed with 2,4-D. Should cultivation be deemed necessary, spot cultivate weedy patches or till north-east, south-west in strips 15 to 20 metres wide, leaving 1½ to 3 metre volunteer grain barriers in between. 2,4-D can be sprayed on the broadleaves in the barriers as required and fall applied herbicides can be incorporated into the tilled strips if desired.

A farm near Gull Lake with field strips arranged in a north and south direction for control of soil drifting.

North and South Stripping Best

North and south stripping is the best arrangement for wind erosion control. East and west stripping is acceptable where it is the only convenient arrangement, but is not desirable.

Width of Strips Vary With Soil Type

Width of strips needed to combat wind erosion is determined mainly by soil texture. Recommended widths for sandy loam soils are 50 to 100 metres; for sandy soils widths of 50 metres or less are necessary. Usually such narrow stripping is required to control soil drifting on very sandy soils that it becomes almost impractical. Sandy soils would be better utilized if continuously cropped or seeded to protective grass-legume cover.

Strip widths recommended for loam soils vary from 100 to 150 metres. Field strips 150 to 200 metres wide should be adequate in places where special care is taken to keep a lumpy surface and trash cover; where field shelterbelts are planted; and where cover crops and grass legumes are used in rotation.

Clay textured soils present a particular problem when attempting to control wind erosion by strip cropping. They readily flake down to a loose granulated condition which shows up following freezing and thawing or after rains. Due to the uniformity of the granulated surface, soil drifting starts over the entire field at the same time. Once started it can be severe even when stripping is used. Severity of drifting, however, may be reduced if strips are held to a 100 metre width.

An important point with clay soils is their capacity to hold moisture and usually produce sufficient crop to ensure adequate residue. With this type of soil, maintaining a good trash cover is necessary even with strip cropping for proper erosion control.

Disadvantages of Strip Cropping

Strip cropping offers some inconveniences and many objections are raised. A common complaint is that soil ridges form on the windward side of stubble strips. Yet, if a blade or heavy duty cultivator is used to keep maximum trash on fallow fields, these soil ridges between strips need not occur. Weed infestation and grasshopper build-up may occur along field margins but with chemical control these are not the problem they used to be. Where sawfly damage is common, it is essential that sawfuly resistant grain varieties be grown on stripped fields.

Three row flax barriers seeded in mid-July in a north-east, south-west direction at 20 metre intervals on a summerfallow field for wind erosion control and as a snow trapping measure.

Occasional shifting of strip margins of five metres or so either way may help overcome weed and insect problems and also soil ridging.

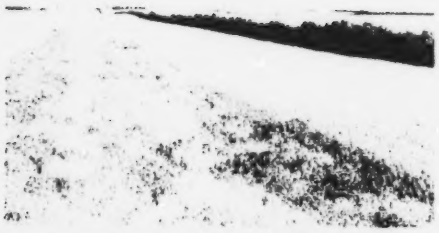
Some farmers feel that large outfits cannot be handled properly on narrow strips but this is not necessarily so. Grazing stripped fields without the expense and inconvenience of cross fencing offers another drawback. Some farmers have used electric fencing to temporarily enclose stripped fields where the grazing available justified this expense.

Repeated travel along headlands of strip cropped fields to cultivate, seed, spray and harvest the various fields pulverizes the soil. Soil pulverization on headlands can initiate erosion which often spreads to adjacent summerfallow strips. Continuous cropping or grassing of headland areas is a means of avoiding this problem.

In extreme situations, as in this Avonlea district field in Spring, 1981, where severe soil drifting had developed, emergency cultivation can be used to bring up lumps in an attempt to curtail the drifting.

Field Shelterbelts For Wind Erosion Control

Trees grown in rows at 100 to 200 metre intervals will greatly assist in wind erosion control by reducing wind speeds. In addition, tree belts trap more snow on fields during winter to give more moisture for the following crop.



A roadside caragana hedge in a field near Melfort. Note excellent stand of brome-alfalfa in roadside ditch.

Field Shelterbelts Help Strip Cropping

Field shelterbelts make strip cropping more effective. A plan often followed is to establish a tree belt along the edge of every other strip in a strip cropped field. Thus, where strips are 100 metres wide, tree rows would be 200 metres apart. This arrangement provides an extra measure of soil drifting control without seriously handicapping regular field work.

Plan of Shelterbelt

In Saskatchewan single row shelterbelts are used almost entirely for field and roadside belts, with caragana by far the most popular species. Many farmers favor a single row containing caragana set 60 centimetres apart. Additional height to the shelterbelt may be obtained by alternating a tall growing tree species with the shrubs.

The mature height of a shelterbelt has a great bearing on sheltering effect received. Experimental work shows wind protection is obtained for a distance of approximately 20 times the height of the trees. Reduction of wind speed is greatest near the shelterbelt.

Shelterbelt Assistance Projects

The Canadian Government established shelterbelt projects at Conquest and Aneroid, Saskatchewan, and Lyleton, Manitoba in 1935. By 1955 the combined area of the projects was more than 900 square kilometres, 373 square kilometres of which were planted to a complete system of shelterbelts. The largest project is at Conquest where more than 1300 kilometres of field shelterbelts have been planted on 710 square kilometres or nearly eight townships of land.

Beginning in 1950 the Saskatchewan Government offered earned assistance payments to Rural Municipalities, Local Improvement Districts, Conservation Area Authorities, Field Shelterbelt Associations and Snow Plow Clubs to encourage field shelterbelt plantings.

By the end of 1976 more than 14,000 kilometres of field and roadside shelterbelts had been assisted under the policy. The earned assistance policy was transferred to the Saskatchewan Department of Rural Affairs in 1977.

Influence of Shelterbelts on Soil Moisture and Crop Yield

Shelterbelts have little effect in reducing evaporation from soil or crops. Experiments by the Soil Research Laboratory, Swift Current, show only a very slight reduction in evaporation near field shelterbelts. However, in a five year study on one group of sheltered fields, net increase of about 70 kilograms of wheat per hectare is reported. Note that this was a net increase even after the area occupied by the trees had been accounted for.

North Dakota research suggests spacing of trees, selection of varieties and maintenance of shelterbelts can improve the distribution of snow for improved gains in cropping as a result of additional stored moisture.

Field Shelterbelts on Sloping Land

Snow banking in narrow tree belts on watershed slopes often aggravates a water erosion problem. This is most serious on heavy textured soils where water enters the soil slowly. Perhaps wider field shelterbelts or block tree planting on upper reaches of a watershed would serve as erosion control measures. More research is needed.

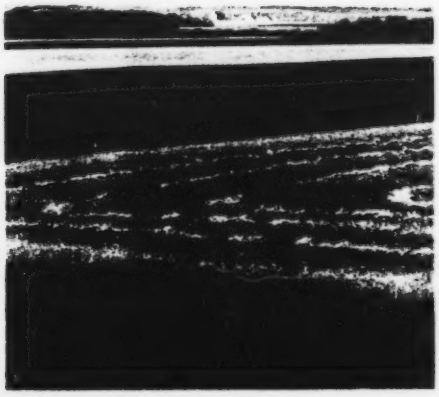
In areas where soil salinity poses a threat there is a danger that shelterbelts may aggravate a saline problem. Prior soil salinity diagnostic investigations should be carried out under these circumstances.

Field and roadside shelterbelts in the Conquest district. Mature field belts make a strip cropping plan more effective.

Saskatchewan Government Photo

Contour Strip Cropping For Water Erosion Control

Farmer experience has indicated improvement in water erosion control through the use of modified contour strip cropping plans. Contour stripping means adapting a regular field stripping design to control water erosion on sloping lands. Alternate strips of summerfallow and crop, arranged on the approximate contour, lessen the severity of erosion on any slope. Each cropped strip running across the slope acts as a buffer impeding the flow of water down the slope. Tillage and seeding across the slope, combined with contour stripping, provide additional checks on run-off water and make field operations easier. Unless some measure of contour farming is adopted on watershed slopes, serious field erosion is the ultimate result.

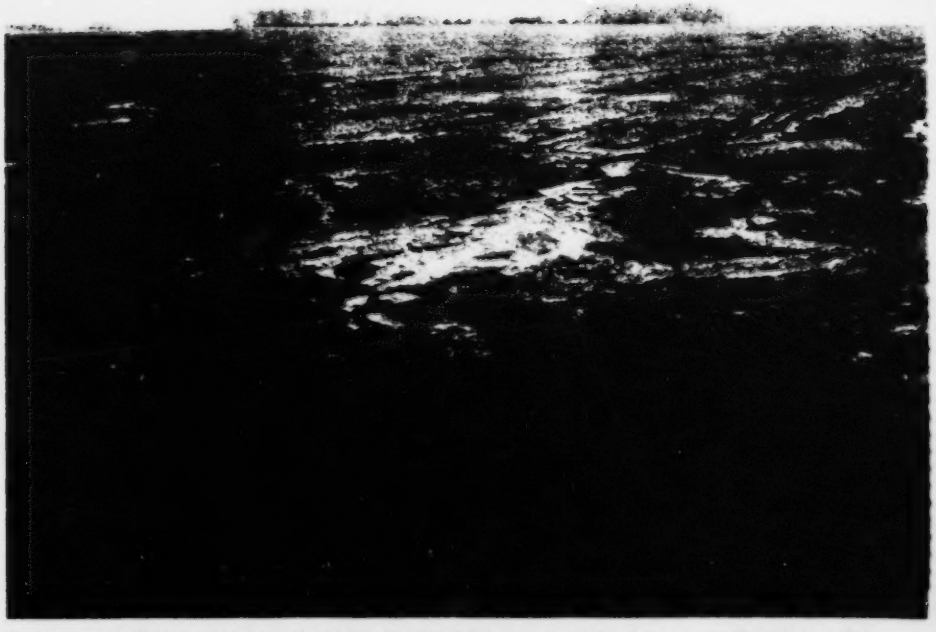


Across the slope strip cropping reduces soil and water losses considerably.

Contour Strip Cropping Designs

Arrangements and width of strips needed for contour farming varies with degree and length of slope, texture of soil, and whether the soil is of lacustrine or glacial till origin. Closest arrangement to the contour and the narrowest strips are needed for silty textured lacustrine soils on long, moderately steep slopes.

Long slopes of uniform direction require no real change from the straight line strip design used for soil drifting control. Fields can be arranged north and south or east and west, whichever allows the strip pattern to be placed most nearly across the main slope. To control water erosion it is important to have the alternate strips arranged approximately at right angles to the slope. Some fields may have to be angled or curved to achieve satisfactory results.



Cropping and tilling up and down the slope permits sheet and rill erosion to occur as illustrated in this field near Hagen. Sheet and rill erosion cause considerable loss of top soil whenever summerfallow on sloping land is farmed in too large a field and particularly if tilled up and down the slope or left without protective cover.

Watershed Management Through Co-operative Action

Group demonstrations of contour strip cropping for control of water erosion have been carried out on watersheds in the St. Louis, Hagen, Birch Hills, Melfort and Tisdale areas. Silty lacustrine soils on long, moderate slopes and large fields cultivated and seeded up and down the slope, set the stage for serious water erosion problems. Excessive snowfall and rainfall during the period from the late 1940's into the early 1950's resulted in the loss of irreplaceable topsoil from entire fields.

Most farmers on sloping lands in these watershed areas now have adopted a contour or modified contour strip cropping plan. This has been brought about by co-operative organizations of farmers on a watershed basis.

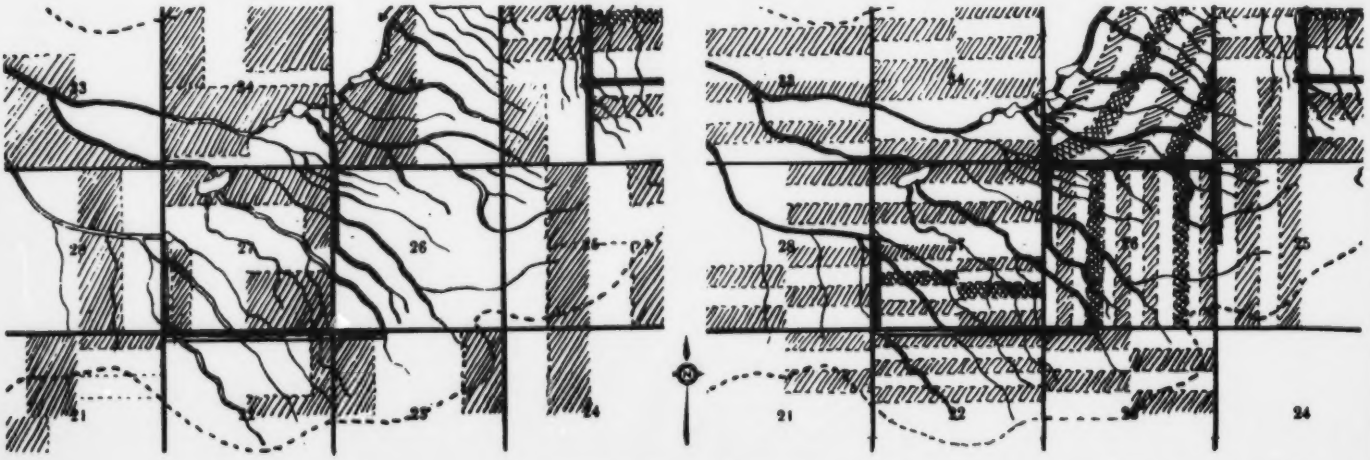
Even in the areas of uniform slopes, it has been impossible to design a strip plan to operate on the contour at all times. Modifications from the contour have been necessary to keep the plan practical. When contour plans are modified, though, greater use must be made of other water erosion control measures, particularly cover cropping, trash cover, fertilizers and manure and grass-legumes.

Widths of strips in watershed projects vary from 50 metres to 100 or 150 metres, depending mainly on the degree and length

Air photo looking south-east across sections 35 and 26 of Galloway Creek Watershed slopes taken during spring run-off 1956. Note erosive nature of water flow across the large bare summerfallow field in centre and the accumulation of silt and floodwaters at the bottom of the slope in foreground. Numerous rills, small gullies and large gullies are evident.

Photo: M. Mac

Maps of the Galloway Creek Watershed slopes, showing soil conservation in practice.



The map on the left shows field arrangements on the Galloway Creek Watershed slopes as existed in 1956. The map on the right shows an improved contour strip cropping arrangement for the same watershed fields. By 1981 most improvements in field arrangements had been put into effect.

Key: plain areas on maps indicate stubble fields; single hatched areas are summerfallow fields; double hatched areas are buffer strips of grasses and legumes; unshaded channels indicate open gullies and shaded channels represent grassed waterways.

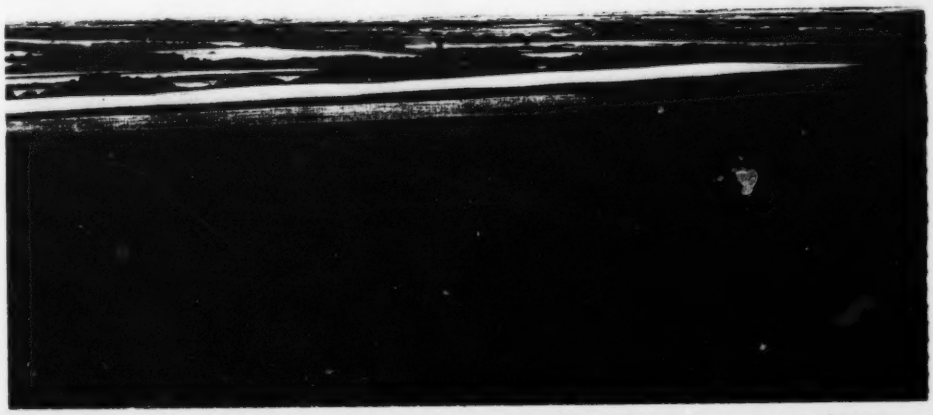
of slope. Most farmers have settled on a 100 metre width, eight field per quarter section design. Where the strip cropping plan is supported by careful contour tillage, use of trash cover, cover crops and buffer strips of brome-alfalfa, satisfactory control of field erosion is obtained.

In periods of adequate moisture it may be desirable to seed every strip, or in other words, continuously crop. Extended cropping is fine provided recommended fertilizer, weed, and insect control measures are practiced. It is most important that, when summerfallow again becomes necessary, former stripping plans are reintroduced.

Contour Strip Cropping In Rolling Areas

In areas of complex rolling topography it is impossible to strip crop fields exactly on the contour. Fortunately, most gently to moderately rolling lands are glacial till soils which resist water erosion better than lacustrine silts or clays. In rolling glacial till areas straight line strip cropping must be accepted as the most satisfactory alternative, although contour cultivation can be practiced.

Under these conditions, if loss of soil through water erosion is to be kept to a minimum, greater stress must be placed upon maintaining a trash cover and cloddy surface.



This modified contour strip cropping plan on the Red Deer Hill slopes, reflects a generous use of brome-alfalfa.

Limited demonstration work in contour strip cropping on gently to moderately rolling areas of lacustrine soils has been carried out in the Viscount area. Field strips 50 to 100 metres wide, arranged in an almost complete circle bordering slough areas at the centre, form the basic part of the plan. The circular strips are of near uniform width throughout and run as nearly across the slope as possible.

On the demonstration farms, a two year fallow-crop or a three year fallow-crop-crop rotation is used. The rotation is kept flexible to permit adjustment to changing conditions of crops and weather, and to permit the rotation of sweet clover or brome and alfalfa through the field strips on these sloping lands. This system serves to protect a higher percentage of sloping land and make it more suitable for grain cropping.

Contour strip cropping design on rolling lacustrine land in the Viscount area. The brome-alfalfa strip, in the lower slope position here, is moved through the other fields in a long term flexible rotation. Summerfallowing is kept to a minimum.

Grassed Waterways and Mechanical Aids For Water Erosion Control

Gully stabilization is an important factor in the control of water erosion. Gullies are signs of improper land use and show that serious field erosion damage is occurring. Recognize gullies while they are still small and take immediate steps to grass them down and correct the land use practices which are causing them.

Grassed waterways are most effective where contour strip cropping is used. They safely transport excess water off watershed slopes and may serve as outlets for interception or diversion channels. Waterways and diversion channels should be protected by grass or grass-legume sod to prevent soil erosion and gullying. Farms laid out for contour strip cropping should have plans for grassing all major waterways.

Flow of water across unprotected areas can cause small gullies to form.

Small gullies, left unattended, soon develop into large gullies which can't be crossed with farm machines. Large gullies represent considerable unproductive acreage, are a potential source of weed infestation and a threat to farm safety.

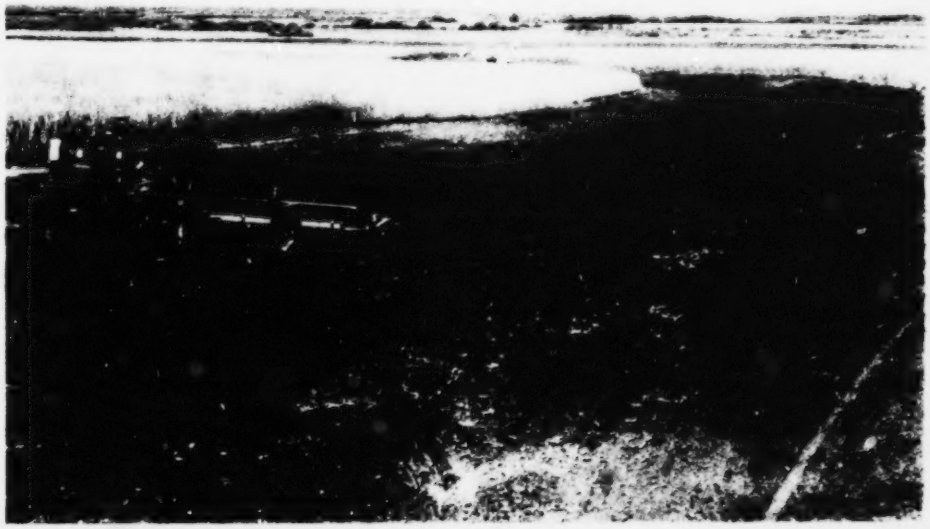
Heavy equipment, like this motor grader, is best for filling, packing and re-shaping large gullies. Where severe meandering occurs in the eroded channel, a caterpillar tractor with dozer or scraper is essential for proper straightening and re-shaping.

Steps in Filling, Shaping and Seeding Gullies

Eroded or gullied waterways should be filled, shaped, levelled and then seeded down. Machines, varying from the farm one-way and cultivator to large dozers and graders, may be used for filling. The choice of machine will depend on the size and condition of the gully. For small gullies farm machines are quite satisfactory. Heavy equipment is needed for large gullies, particularly for brush clearing and straightening of large, meandering channels.

Once filling has been completed, final shaping, packing, seed bed preparation and seeding can be done with farm machines. The entire length of the channel should have a wide, saucer-shaped appearance before seeding to grass. Proper shaping and packing of the water course is vital since this is the only protection against erosion until a cover crop is established.

A brome and alfalfa mixture with nurse crop, seeded at double the normal rate, is recommended for seeding filled gullies. Extra seeding should be done across the channel to provide added resistance to the water flow. The most common mistake is to make grassed waterways too narrow. Seeding should always be done at least one round beyond that which is felt necessary.



Farmer outfit doing final packing, preparing the seed bed and seeding into an improved channel. Rate of seeding recommended is 150 to 200 kilograms of grain with 18 kilograms of brome and 5 kilograms of alfalfa per hectare.

Care of Grassed Waterways

Protect grassed waterways from all tillage operations by raising implements when crossing. They should not be used as a farm roadway or livestock run. Extreme care must be taken when using implements, not to leave a continuous furrow along the edge of the grass or a new gully is likely to form. Edges of grassed waterways should be left jagged or saw-toothed to direct water from nearby slopes onto grassed areas.

Forage growth in grassed waterways should be mowed at the usual haying time. Where excessive growth occurs, it is important that two cuttings are taken.

Farmers not wishing to make a second cutting may, as an alternative, drive down the channel with a packer to flatten the growth in the direction which run-off water will flow. Tall growth left standing over winter creates greater snowbanks in the channel and adds to the danger of water running down the outside causing erosion, or even a new gully during spring run-off.

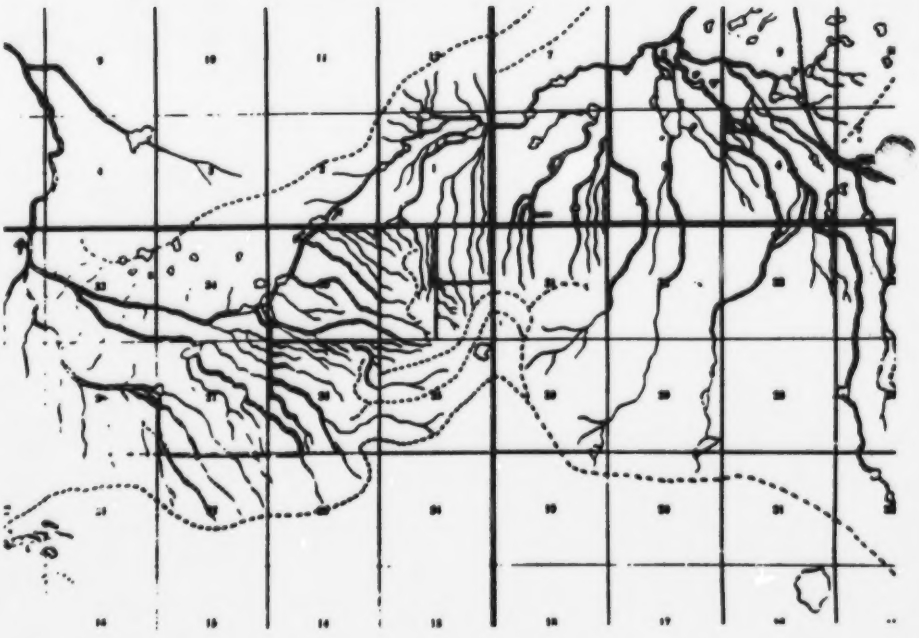
A completed grassed waterway, stabilized with brome-alfalfa cover, is a safe and productive asset to the farm. Note the contour cropping along the waterway slopes.

Watershed Co-operative Approach

Nineteen watershed groups in the province have been incorporated as watershed co-operatives since 1956. The first concern among members of these groups has been waterway improvement and grassing. In the early established watershed co-operatives, most of the channel improvement work has now been completed. Other recommended measures for water erosion control such as contour strip cropping, trash cover farming, cover cropping, use of grass-legumes, are now receiving major attention.

A total of approximately 500 kilometres of waterways have been improved and grassed under this policy to the end of 1981. On Galloway Creek Watershed, the first co-operative organized, members have completed over 50 out of a total of 60 kilometres of main channel improvement. Members in the newest group, Flett Creek Watershed Co-operative, have about 60 out of 90 kilometres of waterway improvement and grassing yet to do.

Saskatchewan Agriculture has offered assistance in gully control work on individual farms and also in channel improvement to the Watershed Co-operatives. Agricultural Representatives should be contacted for details of the policy.



Field map showing small tributaries and larger runs which carry run-off water to the Galloway Creek Channel on the left and the Mack Creek Channel on the right. The shaded water courses indicate those improved and grassed up to 1956; the open courses represent eroded gullies. Most of the open gullies on these watersheds have since been improved and grassed.

Interception Channels

Interception diversion channels are used on some farms to gather run-off water from watershed slopes and control its flow into established grassed waterways. This practice lessens the danger of many small gullies forming as water accumulates on long slopes. Terraces and contour furrows, used in countries subject to high rainfall and severe erosion, are also intended as aids in controlling rill and small gully erosion. Because of our climate and rainfall pattern, these measures are not generally recommended for Saskatchewan.

Mechanical Aids

To control a large gully, it may be necessary to use temporary check dams of straw, brush, rock or wire to protect it until vegetation becomes established. Permanent structures of earth or reinforced concrete may be used as retention reservoirs for gully and flood control, with the added benefit of water storage for urban or farm use or for irrigation. Temporary check dams are discussed in some detail in Agriculture Canada's publication "Soil Erosion by Water" available from Federal or Provincial Department of Agriculture offices. Before using mechanical aids to stabilize gullies or attempting special practices to intercept and divert water, engineering services should be secured.

A wide grassed area is necessary to contain the excessive amount of water which often accumulates from spring run-off or after intense summer storms. In an extended saucer-shaped, grassed channel, the water runs wide and shallow and very little erosion and silting occurs.

Cover Cropping For Soil Erosion Control

The practice of late summer seeding of spring wheat, oats, barley or fall rye as cover crop provides a measure of soil erosion control on summerfallow fields. When there is enough moisture for good growth soil protection is assured, and fall pasture may also be provided.

Cover crops are usually seeded at half the rate of a crop for grain. The best time to seed will vary from one part of the province to another but is usually during the first part of August.

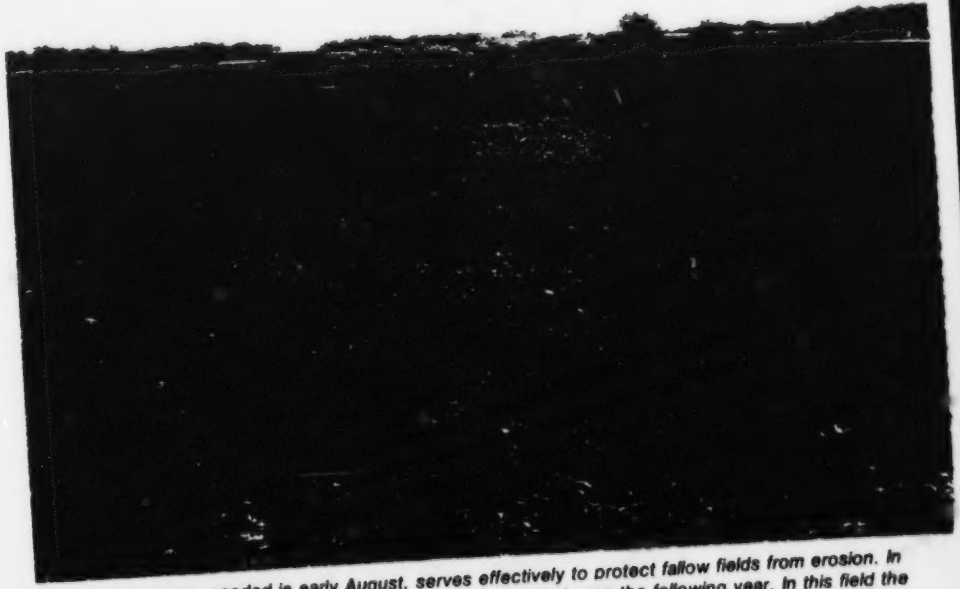
The cover cropped summerfallow field on the right traps as much snow over winter as does the stubble field on the left.

Disadvantages of Cover Cropping

The most obvious disadvantage is the loss of stored moisture from summerfallowed fields especially if seeded too early, or in long, frost-free fall seasons when growth continues late. Moisture used by cover crops, though, is usually regained from the additional snow trapped throughout the winter.

Another disadvantage is that a cover crop will temporarily tie up some of the nitrogen made available by summerfallowing. As a result, the succeeding crop may have to be fertilized at rates recommended for stubble crops.

Dry seasons create another drawback. There may not be enough moisture to germinate the seed. It is in dry seasons that extra cover for erosion control is important; therefore, this situation can be serious. This emphasizes the importance of adopting a strip cropping plan and maintaining trash cover on fallow as the basis for soil protection. Cover cropping in dry areas, unless required for pasture, should be thought of as an emergency measure to strengthen other accepted practices in erosion control.



Fall rye cover crop, seeded in early August, serves effectively to protect fallow fields from erosion. In addition, it can provide fall and spring pasture and hay or seed crop the following year. In this field the healthier growth of fall rye on the right was fertilized with 11-48-0 at 45 kilograms per hectare at seeding time.

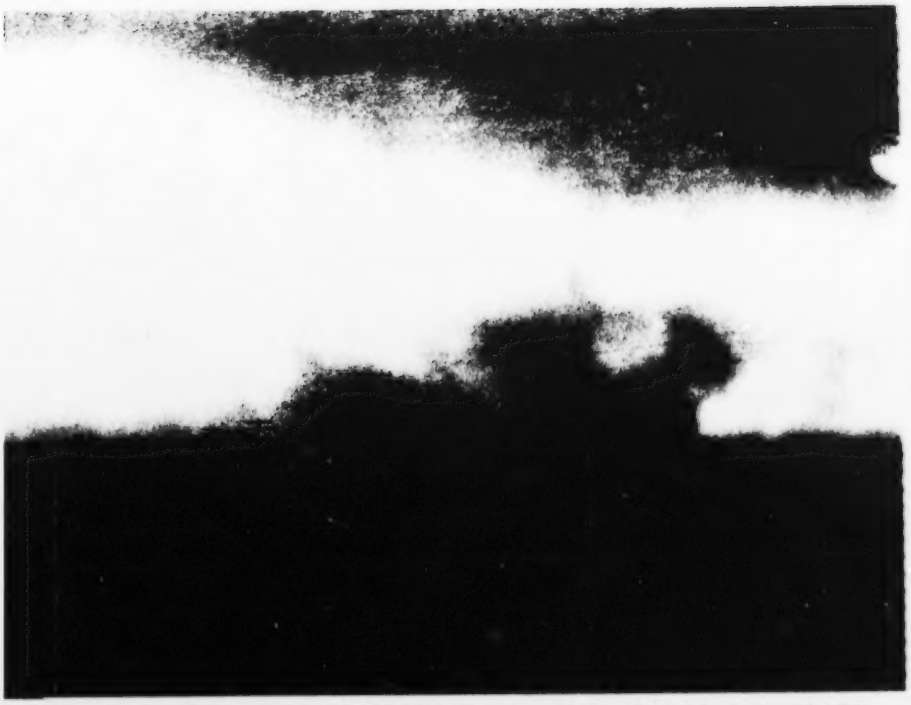
Emergency Uses

Emergency situations often occur on sandy and light loam soils. Fall rye is commonly grown as a cover crop on such light textured soils. It offers protection against soil drifting and also provides fall and spring pasture and a potential hay or seed crop the following year.

Some farmers with a heavy clay soil, such as on Regina plains, use cover crops for emergency protection against soil drifting. Rather than seeding entire fields, cover crops are often seeded in parallel strips at right angles to prevailing winds, providing a temporary strip crop design. This practice seems well suited to clay soils where it is difficult to keep a cloddy surface and to any area where regular strips are too wide. Difficulty in getting cover crops established during a dry season is a drawback.

Cover Crops for Water Erosion Control

Silt and clay textured soils on long, moderately steep slopes need cover crops to complement other recommended practices for satisfactory water erosion control. Cover crops are especially useful when seeded in small runs or portions of fallow strips where run-off water accumulates. Entire summerfallow strips may be seeded for better protection.



An intense summer storm causes severe soil drifting from summerfallow fields in background but little soil loss from cover cropped fields in foreground.

Cereal grain, seeded into small runs in early August of the summerfallow year, serves to protect these vulnerable areas from water erosion at time of spring run-off.

Grasses and Legumes in Rotation for Soil and Crop Improvement and Erosion Control

Grasses and legumes, fitted into the farm rotation, give soil protection while actively growing. In addition to providing crops of hay or pasture, they add extra organic matter and improve soil productivity for following crops.

A second year stand of brome and sweet clover was broken after haying on the left 50 meters of this 100 meter field. The extra surface residue left after brome and clover give more protection to the soil and better water absorbing ability. The extra surface materials plus the more extensive rooting of the grass-legume mean more organic matter build-up and improved soil tilth.

Forage Crops Mean Better Erosion Control

Where wind erosion is a constant problem, forage crops are needed in the farm rotation. Sandy and sandy loam soils drift easily and trash cover and strip cropping may not provide enough erosion control.

The more sandy the texture the greater should be the percentage of grasses and legumes used. Extremely sandy soils in dry regions of the prairie area are best utilized if seeded to a permanent cover of crested wheatgrass or preferably a mixture of crested wheatgrass and alfalfa. A rotation including brome and alfalfa usually controls wind erosion on sandy lands in the more moisture efficient park-belt and wooded areas of Saskatchewan.

A grass-legume mixture permits more water to enter the soil and lessens the damaging effect of water erosion where silt and clay soils occur on long, moderately steep slopes. The deeply penetrating, extensive roots of forage crops, especially alfalfa, but also grasses and sweet clover, help to make the soil more permeable.

Experimental Evidence

In a Wyoming study on a silty clay loam soil with two to three per cent slope, simulated rainfall was applied to soils with a bare fallow surface, and a perennial sod cover, at a storm intensity of 7.5 centimetres an hour. The grass-alfalfa mixture increased total water absorption to 5.4 centimetres from 3.9 centimetres for the bare fallow, in a one hour run.

On steeply sloping land the grass-legume mixture in foreground absorbs most of the water from even an excessive rainfall and holds erosion to a minimum. The bare summerfallow field in background couldn't withstand the intense summer rain storm, as exemplified by severe rilling and gullying and silt deposition.

Established forage stands provide the type of cover to sloping lands which literally "walks" excess water off the fields and cuts soil losses to a minimum. A study of soil losses on a ten per cent slope have been recorded for different cropping practices, on a Rideau clay soil at Ottawa. Soil losses during a 12-year period were as high as 513 tonnes per hectare for bare fallow compared with a low 0.5 tonnes per hectare where alfalfa was grown to protect the soil.

Organic Matter Added by Grasses and Legumes

The extra organic matter added to the soil when forage crops are grown is of great benefit in erosion control. Grasses return more fibre to the soil than cereal crops.

Legumes, besides returning considerably more fibre, also transpose air nitrogen to the soil's storehouse through their root nodules. The extra nitrogen, which legumes supply, aids in the decomposition of raw fibre to humus — a product vital to soil aggregate formation and stability.

Nitrogen Added by Legumes[1]

The amount of nitrogen "fixed" by a legume crop varies. It is estimated that alfalfa or sweet clover will add up to 80 to 100 kilograms of nitrogen per hectare annually. (Refer Table 3, page 9). This is as much nitrogen as obtained by applying 235 to 295 kilograms of ammonium nitrate fertilizer per hectare. The extra nitrogen supplied to the soil by repeated use of legumes in rotation results in a greater total soil nitrogen and organic matter content.

At the end of a 13-year experiment on sandy loam soil at Melita, Manitoba, sweet clover green-manure fallow showed a 16 per cent increase in nitrogen and a 30 per cent increase in organic matter over summerfallow in a regular grain rotation. An alfalfa-grass rotation on silt loam soil at Pullman, Washington, increased the content of nitrogen in the soil from 0.107 to 0.114 per cent in 19 years. At the same time the nitrogen value for fallow-wheat soil was 0.092 per cent, or about one-fifth less than that for the alfalfa-grass cropping system.

Forage Crops in Rotation Mean Improved Soil Tilth

Additional organic matter supplied by grasses and legumes, works both directly and indirectly to help soils resist erosion. In a direct way fresh organic residues, high in nitrogen, stimulate the soil micro-organisms to greater activity. Increased activity in the decomposition process releases extra microbial gums and humus which helps bind single grain soil particles into larger aggregates.

Improved aggregation means improved friability and permeability of clay soils, improved water retention capacity of sandy textured soils, and improved structure of all mineral soils. High quality organic matter as supplied by forage crops directly influences soil tilth and lessens erosion.

Experimental Evidence

The University of Alberta's Breton fertility plots, on a Gray-Wooded soil, show a marked improvement in surface condition of

Cattle grazing in a brome-alfalfa pasture in the Northern Light district. Grasses and legumes protect and improve the soil and increase meat and dairy production.

Green manuring sweet clover in mid-June.

[1]Reference: — Alberta Forage Seed Council's publication, "Plowdown — A Strategy for the Eighties".

the soil following legume use over a 29-year period. Soil aggregate size from plots in a five-year grain-legume rotation was compared with soil aggregate size from plots in a wheat-fallow sequence.

Results show that the average diameter of soil aggregates on the legume plots was over 1½ times the diameter of aggregates on the continuous grain plots. In other words, the surface soil condition following legume use would appear to be up to 50 per cent better for moisture absorption and erosion control than following straight grain.

Forage Crops in Rotation Mean Increased Grain Production

Grass and legume crops in a rotation usually increase the yield of succeeding grain crops. This in turn means extra crop residues to provide still more soil protection. The value of extra grain crop residues produced should not be underestimated. Adequate trash cover is still the prime factor in erosion control even after the soil's organic matter has been improved through grass-legume use.

Experimental Evidence

On the Breton plots in Alberta, where improvement in stability of soil aggregates after legumes has been reported, substantial grain yield increases have also been noted. The 29 year average yield of wheat in a five-year rotation including legumes is 1460 kilograms per hectare and of wheat grown in the summerfallow-wheat rotation only 660 kilograms per hectare.

At the Melfort Research Station's White Fox Farm on a Grayish-Black fine sandy loam soil, the 27-year average wheat yield on summerfallow in a six-year rotation including a grass-legume mixture is 2349 kilograms per hectare. The average wheat yield on fallow in a three-year grain rotation for the same 27-year period is only 1421 kilograms per hectare. Oats on stubble in the grass-legume rotation show a long term yield increase of more than 697 kilograms per hectare over second crop oats in the three-year rotation — the 27-year average yields being 1688 and 997 kilograms per hectare respectively.[1]

Sweet clover and red clover have proven to be valuable soil improvement crops in short term rotations. Results from the Melfort Research Station's Star City Farm, on a Gray-Wooded loam soil, show a four-year average summerfallow wheat yield after sweet clover of 1762 kilograms per hectare compared to only 1419 kilograms per hectare in a straight grain rotation.

[1]Reference: — The Effect of Controlled Cropping on Degraded Soil. CDA. 1967.

A field of second crop barley ready for the combine. The heavier swaths noticeable on the upper left, reflect the beneficial influence of an alfalfa crop broken out six years before. Many farmers report improved crop production for a number of years following legume or grass-legume use.

Other similar experimental findings could be listed to illustrate the value of grass and legume use in rotation for soil improvement and erosion control. Equally important, the observation and findings of farmers throughout the province could be quoted to bear out the results of research. Forage crops will undoubtedly become of ever increasing importance in the battle to hold soil erosion in check and to maintain a productive soil for the future.

Two youthful conservationists examining the improved soil tilth in a field recently broken from brome-alfalfa.

Summary

Productive soils are, in a real sense, pulsating with life. The nature and organization of any soil's physical, chemical and biological properties determines its productive potential and erosion resisting ability. Physical properties of the soil can be thought of as the raw materials; chemical properties as the finished product, plant food; and biological properties as the agency making life possible.

The chief biological agent is man himself. He influences the character of the soil through cultivating, harvesting, deforestation, drainage, irrigation, manuring and farming practices generally. It is within man's power either to increase or decrease the productive capacity of the soil and to control erosion on the land.

In the final analysis, sound conservation involves the application of recognized erosion control measures to farm lands, according to their need. Nine steps to successful soil conservation have been discussed in this bulletin and are graphically reproduced here. Nc one of these steps taken alone will lead to complete soil erosion control. Several steps usually are necessary for an effective program in soil conservation.

Increased production and greater farm worth are two important benefits resulting from wise use of the conservation steps needed on any farm. Among other equally important benefits are pride of achievement and satisfaction in a job well done.

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Photo credits are gratefully acknowledged. Where credits are not indicated, the photos are those of the author.

Save the Soil

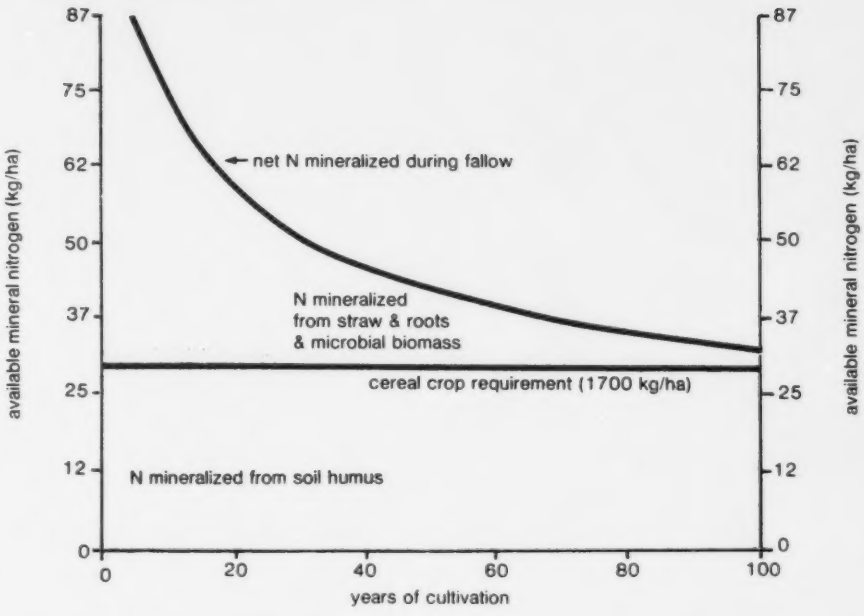
First Printing 1964. Reprinted 1975
Revised and Reprinted 1982

Appendix A

The diagram shows the net N mineralized from the soil during an average summerfallow period in Saskatchewan. The "" comes from two sources, the soil humus] the recent straw, rootlets and the soil microbes. The horizontal line represents the amount of N required by a 1700 kg/ha wheat crop.

The graph shows that when prairie sod was broken and tilled for growing grain the amount of N released from the rich prairie soils during a fallow period was more than enough to grow a crop. The straw could have been used and if removed, there would still have been excess N produced from the humus alone to satisfy an average crop. As time has progressed tillage and erosion have caused a great depletion in the ability of humus to supply N, and after summerfallowing for a year many soils must still be fertilized with N. Now, and even more so in the future, it will be necessary to conserve as much straw as possible to reduce the need for N fertilizer, to maintain a productive soil and to resist erosion.

A Model Showing Past, Present and Future Soil Nitrogen Trends
(Campbell, McGill and Paul).



Appendix B

Metric ⇄ Imperial Conversion Table*

Metric to Imperial	Multiply by Approximate Conversion Factor		Imperial to Metric	Multiply by Approximate Conversion Factor	
Metric Unit		**Imperial Unit**	**Imperial Unit**		**Metric Unit**
Linear					
millimetre (mm)	0.039	inch	inch	25.4	millimetre
centimere (cm)	0.39	inch	inch	2.54	centimetre
metre (m)	1.09	yard	yard	0.91	metre
kilometre (km)	0.62	mile	mile	1.6	kilometre
Weight					
gram (g)	0.035	ounce	ounce	28.00	gram
kilogram (kg)	2.20	pound	pound	0.45	kilogram
tonne (t)	1.10	ton	ton	0.91	tonne
Area					
square centimetre (cm^2)	0.155	square inch	square inch	6.5	square centimetre
square metre (m^2)	10.76	square foot	square foot	0.09	square metre
hectare (ha)	2.47	acre	acre	0.40	hectare
square kilometre (km^2)	0.386	square mile	square mile	2.59	square kilometre
Volume					
cubic centimetre (cm^3)	0.06	cubic inch	cubic inch	16.00	cubic centimetre
cubic metre (m^3)	1.31	cubic yard	cubic yard	0.76	cubic metre
millilitre (ml)	0.035	fluid ounce	fluid ounce	28.00	millilitre
litre (l)	0.22	gallon	gallon	4.55	litre
Pressure					
kilopascal (kPa)	0.145	pounds per square inch	pounds per square inch	6.89	kilopascal
Speed					
kilometres per hour (km/h)	0.625	miles per hour	miles per hour	1.6	kilometres per hour
Agricultural					
kilograms per hectare (kg/ha)	0.89	pounds per acre	pounds per acre	1.12	kilograms per hectare
litres per hectare (l /ha)	0.089	gallons per acre	gallons per acre	11.23	litre per hectare
millilitres per hectare (ml/ha)	0.014	fluid ounces per acre	fluid ounces per acre	70.00	millilitres per hectare
tonnes per hectare (t/ha)	0.45	tons per acre	tons per acres	2.24	tonnes per hectare
Wheat, peas, beans, corn					
kilograms per hectare (kg/ha)	0.015	bushels per acre	bushels per acre	67.25	kilograms per hectare
Oats — kilograms per hectare (kg/ha)	0.026	bushels per acre	bushes per acre	38.11	kilograms per hectare
Barley, buckwheat — kilograms per hectare (kg/ha)	0.019	bushels per acre	bushels per acre	53.80	kilograms per hectare
Canola, mustard — kilograms per hectare (kg/ha)	0.018	bushels per acre	bushels per acre	56.04	kilograms per hectare
Corn, flax, rye — kilograms per hectare (kg/ha)	0.016	bushels per acre	bushels per acre	62.77	kilograms per hectare

*Example = to convert millimetres to inches, multiply by .039; conversely, to convert inches to millimetres, multiply by 25.4